Large-Scale Deployment of Discarded Conch Shells Enhances Juvenile Habitat for Spiny Lobster, Nassau Grouper and Red Hind

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ABSTRACT

In the Turks and Caicos Islands (TCI), discarded queen conch shells are important shelter for juveniles of spiny lobster (*Panulirus argus*), Nassau grouper (*Epinephelus striatus*), and red hind (*Epinephelus gutattus*), all species important to local fisheries. Small scale artificial enhancement of conch shells is known to increase the abundance of these species, but use of this strategy on a scale significant for fisheries had not previously been tested. In January 2009, 1,800 conch shells were placed in three plots in a contiguous 600 m long stretch of seagrass in Cockburn Harbour, South Caicos, TCI. Plots were spaced at increasing distance from the reef and were subsequently surveyed 8 times between May 2009 and April 2010. Juvenile spiny lobster, Nassau grouper, and red hind were observed in all three plots. Spiny lobsters were almost 10 times more abundant than groupers. Densities of lobsters peaked in January 2010 at 1 lobster in every 10 to 16 conch shells and densities remained high throughout the study period. Densities of the groupers were substantially lower with a maximum density of 1 Nassau grouper every 75 shells and 1 red hind every 150 shells. Despite being congeners, Nassau grouper were more abundant with increasing distance from the reef and red hind displayed decreasing abundance with distance from the reef. A strategy to enhance nursery function of seagrass with discarded conch shells appears to be most effective for spiny lobsters rather than groupers.

KEY WORDS: Queen conch, spiny lobster, red hind, Nassau grouper, seagrass

Utilización a Gran Escala de las Conchas del Caracol Reina Aumentan el Habitat de Juveniles de Langosta Espinosa, Mero de Nassau y Mero Colorado

En las islas de Turks & Caicos (TCI), las conchas desechadas del caracol reina son refugios importantes para jóvenes de langosta espinosa (*Panulirus argus*), mero de Nassau (*Epinephelus striatus*) y mero colorado (*Epinephelus guttatus*), todas especies comercialmente importantes. El aumento de las denisidades de estas especies fueron realizadas por poniendo conchas desechadas, pero sólo investigaron a una escala pequeña. No probaron si el uso de conchas a un gran escala puede ser una estrategia útil para aumentar las pesquerías. En enero 2009, ponemos 1800 conchas en 3 parcelas en una área contigua de 600 m de hierba marina en Cockburn Harbour, South Caicos, TCI. Las parcelas fueron situadas con distancia creciente del arrecife. Desde mayo 2009 hasta abril 2010, visitemos a las parcelas ocho veces. Observemos jóvenes de langosta espinosa, mero de Nassau y mero colorado en todas las parcelas. La abundancia de langosta espinosa estuvo 10 veces de la abundancia de los meros. La densidad de langosta espinosa alcanzó el máximo en enero 2010, a 1 langosta cada 10 a 16 conchas, y la densidad alta duró hasta el fin del studio. La densidad máxima de mero de Nassau fue un individuo cada 75 conchas, y por mero colorado un individuo cada 150 conchas. A pesar de ser del mismo genus, los meros de Nassau fueron más abundantes con distancia creciente del arrecife y los meros colorados fueron menos abundantes con distancia creciente del arrecife. Una estrategia para aumentar la función criadera de los pastos marinos con conchas deseschadas parece que ser más efectiva para langosta espinosa que los meros.

PALABRAS CLAVE: Cherna criolla, identificación con foto, marcas naturales, pastos marinos

Déploiement à Grande Échelle des Coquilles Vides de Lambis Augmente Habitats pour les Juvéniles de Langouste Blanche, Mérou Rayé et Mérou Couronné

Dans les Îles Turks et Caicos (TCI), les coquilles de lambis vides sont abris important pour jeunes de langoustes blanches (*Panulirus argus*), mérous de Nassau (*Epinephelus striatus*) et mérous couronnes (*Epinephelus guttatus*), touts commercialement importantes. L'augmentation des densités de cettes espèces était réalisée par le deployment de coquilles, mais on a étudié seulement d'une échelle petite. On n'a pas mis à l'épreuve l'utilisation de coquilles à grande échelle comme une stratégie améliorer de la pêcherie. En janvier 2009, 1800 coquilles de lambis étaient posées dans 3 parcelles dans un zone des herbiers de 600 m, à Cockburn Harbour, South Caicos, TCI. Les parcelles étaient prepares distance croissante du récif. Entre mai 2009 et avril 2010 nous avons inspecté les parcelles 8 fois. Nous avons observe des jeunes de langoustes blanches, mérous de Nassau et mérous couronnes dans toutes les trois parcelles. Langoustes blanches étaient presque 10 fois plus abondantes que les mérous. La densité des langoustes était la plus grande en janvier 2010, à 1 langoustes chaque 10 ou 16 coquilles, et la densité a resté grande jusqu'au fin de l'expérience. Les densities des mérous étaient considérablement plus bas, à 1 mérou de Nassau chaque 75 coquilles et 1 mérou couronne chaque 150. malgré, en dépit d'être du meme genus les mérous de Nassau étaient plus abondants le plus loin du récif, et les mérous de couronnes le plus proche du récif. Il paraît qu'une stratégie d'améliorer le rôle de nurserie des herbiers avec coquilles de lambis vides est plus efficace pour les langoustes blanches que les mérous.

MOTS CLÉS: Lambis, langouste blanche, mérou de Nassau, mérou couronne

INTRODUCTION

In the Turks and Caicos Islands (TCI) there are three main fisheries: primarily spiny lobster (*Panulirus argus*) and queen conch (*Strombus gigas*) (Béné and Tewfik 2001, Medley and Ninnes 1999), with a growing fishery targeting reef fishes of various species especially groupers (Serranidae) and snappers (Lutjanidae) (Rudd 2003, Rudd and Tupper 2002). The conch fishery has harvested over one million individuals annually since the mid 1970s (Béné and Tewfik 2001). Their shells are discarded as a waste product and usually piled in middens at sea or at specific locations on the intertidal zone around the islands. Discarded conch shells are known to serve as shelter for a large number of species of fishes and invertebrates, and the formation of these middens is encouraged in order to create juvenile habitat for fishes (Wilson et al. 2005).

However, further studies in the TCI revealed that at sizes < 20 cm total length Nassau grouper (*Epinephelus striatus*) and red hind (*E. guttatus*) prefer solitary discarded conch shells in seagrass beds as shelter sites rather than middens (Claydon and Kroetz 2008, Claydon Unpub. data). Nearly 50% of early juvenile Nassau grouper and red hind were observed sheltering in conch shells (Claydon and Kroetz 2008). Juvenile spiny lobsters were also frequently observed residing in solitary conch shells in seagrass (Claydon Pers. observation). Following these observations, a small scale experiment was conducted to assess whether deployment of conch shells within seagrass could enhance densities of Nassau grouper and spiny lobster (Claydon et al. 2009). Densities were increased by 37 and 150 times respectively compared to control areas. However, it was unknown whether the impressive increase in densities would be sustained if the approach was scaled up. The aims of the present study were to assess whether the large-scale deployment of conch shells within seagrass beds could enhance densities of spiny lobster, Nassau grouper and red hind to an extent that would be meaningful as a tool to enhance local fisheries.

METHODS

In January 2009, 1800 conch shells were placed in 3 plots of 600 in a contiguous 600 m long stretch of seagrass in Cockburn Harbour, South Caicos, TCI, ranging in depth from 1 to 3 m (Figure 1). Within plots, shells were deployed in a 2 m x 2 m grid, with apertures facing upwards to prevent being closed off by lying against the substratum. The dimensions of plots were determined by the borders of the seagrass bed and by avoiding deploying shells in blowout areas. Thus, plots were approximately rectangular with dimensions of between 30 to 70 m. Plots were spaced at increasing distance from the reef and were subsequently surveyed eight times between May 2009 and April 2010. Surveys were conducted systematically on snorkel recording the presence or absence of spiny lobster, Nassau grouper and red hind within every conch shell deployed in all three plots. The location of all occupied shells was recorded using a handheld GPS unit (Garmin GPSMap76).

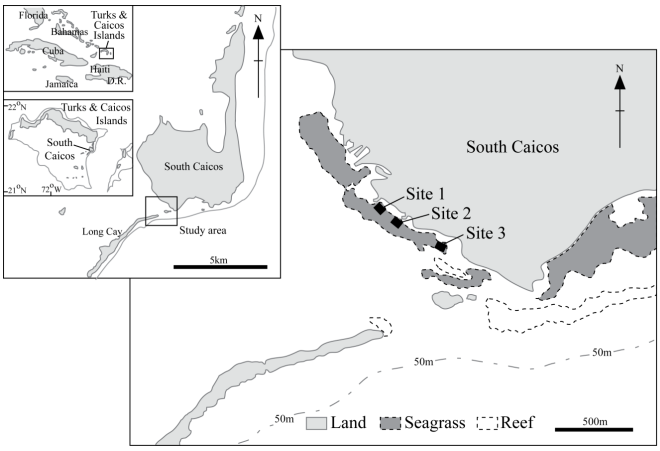

Figure 1. Study area, South Caicos (N 21°29' W71°31'), TCI.

RESULTS

Although spiny lobster was the most abundant species found in conch shells, Nassau grouper and red hind were also observed in all three plots (Figures 2 & 3). Initially, densities of all three species found sheltering in conch shells rose following deployment in January 2009. Across the three plots as a whole, Nassau grouper peaked in September 2009 with 15 individuals observed; red hind peaked the following month with 5 individuals; and spiny lobster peaked in January 2010 with 147 individuals (equating to a density of 204/hectare). Following their peaks, Nassau grouper and red hind abundance declined and were not observed after March and February 2010 respectively. However, lobster remained abundant through to the end of the experiment.

There were distinct differences between the assemblages of species between sites, with a gradient of more Nassau groupers with increasing distance from the reef (higher densities at site 1 and lowest at site 3) and the opposite pattern being observed for red hind.

DISCUSSION

The large scale deployment of conch shells appeared to be most successful in enhancing densities of spiny lobsters, with the increases in densities of groupers not being of a magnitude significant to fisheries: 1800 shells were occupied by a maximum of 15 Nassau grouper and 5 red hind during the observations, as opposed to 147 lobster. However, in 2007, the same areas were surveyed and no red hind were observed at all within the study sites and only 5 Nassau grouper were seen, representing substantial increases compared to this baseline. In addition, there is anecdotal evidence that around South Caicos in general, recruitment was lower during the study period compared to 2007. In order to stimulate meaningful increases in abundance of early juvenile groupers it would be necessary

to deploy an even greater number of conch shells within seagrass (covering greater areas, rather than increasing number of shells per m^2). However, a scenario whereby entire seagrass beds are covered with conch shells may be neither feasible nor desirable.

The experiment did not address what factors are driving the increase in densities. Rather than simply being a case of attracting individuals from elsewhere, conch shells must reduce mortality in some fashion. Shelter sites (e.g. sponges, shells, solution holes, etc.) are limited in seagrass (Briones-Fourzán et al. 2007) and for spiny lobsters this has been shown to increase mortality through predation (Smith and Herrnkind 1992). Around South Caicos, the quantity of available shelter sites is likely to have been greatly reduced by two hurricanes that hit the TCI six months before the start of the experiment. The hurricanes stripped seagrass beds of much of their structure beyond blowouts and the seagrass itself (Claydon pers.obs.). Although research is absent on groupers, a number of studies have demonstrated that artificially enhancing the density of available shelter sites reduced predation on juvenile spiny lobsters (Butler and Herrnkind 1997, Eggleston and Lipcius 1990, Eggleston et al. 1992, Herrnkind et al. 1997, Mintz et al. 1994). Thus, the deployment of conch shells may decrease predation on juveniles of spiny lobster and grouper in a similar fashion.

In addition, the shelter provided by conch shells may be of a better quality than other available shelter. In order to function as an effective refuge from predation, the dimensions of shelter have to match those of the potential

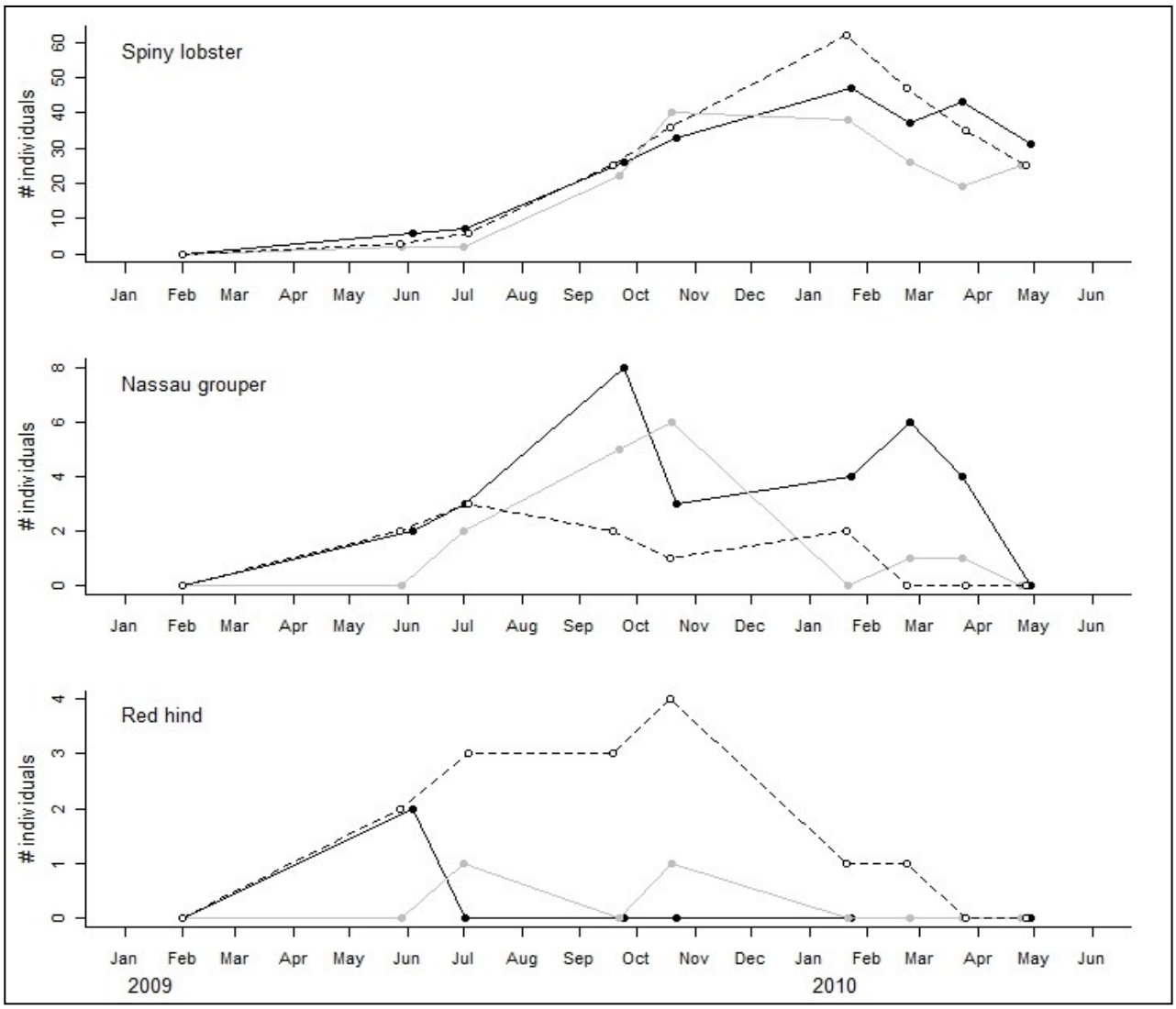

Figure 2. Spiny lobster, Nassau grouper, and red hind sheltering within conch shells over time (from deployment in late January 2009 to April 2010). Black line – site 1, grey line – site 2, dashed line – site 3.

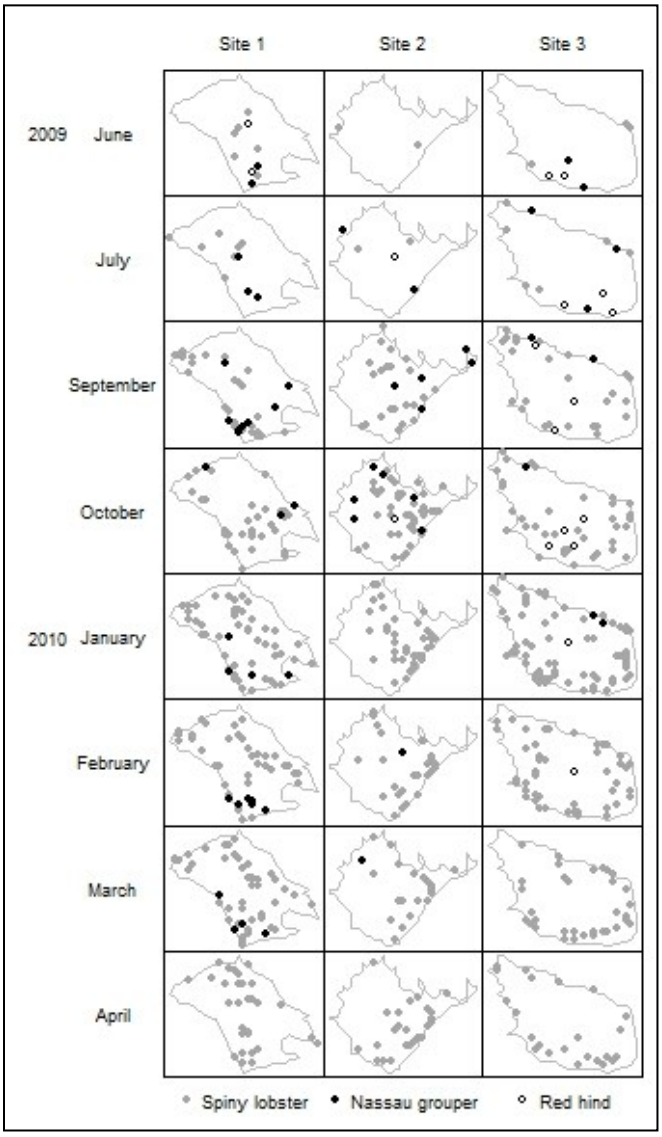

Figure 3. Location of spiny lobster, Nassau grouper, and red hind sheltering within conch shells in each site over time. Each dot represents one individual.

prey (Eggleston and Lipcius 1990, Eggleston and Lipcius 1992, Eggleston, Lipcius and Miller 1992). Shelter works because predators are usually larger than their prey, and so prey hide within a structure that is too small for the predators to access. However, if the shelter is too large then predators are not effectively excluded, and if the shelter is too small then prey cannot effectively hide within. The inside of a conch shell is essentially a spiralling tube that gets progressively thinner further into the shell. Thus, in order for an animal to avoid being preyed upon it only needs to retreat into the conch shell up to a point where it fits comfortably but a potential predator is too large to enter. The conch shell is therefore a shelter for a range of sizes. Most other potential shelter sites do not have such characteristics and thus may only be suitable for certain sized individuals and cannot accommodate the broad range of sizes that conch shells can. In the absence of discarded conch shells, individuals will have to seek successive shelter sites that are size-specific or suffice with a shelter structure that is suboptimal. Both scenarios increase the risk of predation: from being exposed whilst seeking, and not necessarily finding, appropriate alternative shelter sites, or from being exposed to predators by remaining in a shelter site that they have effectively outgrown or not yet grown into. Thus, regardless of whether shelter sites are limited within seagrass, providing better quality shelter sites may reduce mortality.

Although the present study investigated the potential of conch shell deployment as a fisheries tool, for Nassau grouper and red hind, the strategy may be more important for conservation. Within this context, the small (by number) increase in groupers is meaningful. This becomes especially pertinent when viewed in the context of the red lionfish invasion, *Pterois volitans*, of South Caicos. Red lionfish were first observed around South Caicos in 2007. By the end of the present experiment, 22 individuals were captured in the contiguous seagrass bed where the study sites are found. Lionfish were found exclusively in blowout areas, mostly using the ledge formed by roots and rhizomes as shelter (as described in Claydon et al. 2009). Blowout areas in general and blowout ledges are also favoured (micro)habitat of spiny lobster, Nassau grouper and red hind within seagrass beds (Claydon and Kroetz 2008). As lionfish become more established within these areas, this may have negative effects on the fisheries species through competition for space and prey, and through being preyed upon by lionfish, with grouper and lobsters being observed in lionfish stomachs elsewhere (Morris and Akins 2009). However, over 100 lionfish have been observed in seagrass beds around South Caicos, and none have been documented using solitary conch shells as shelter (Claydon Unpubl. data). Thus, the deployment of conch shells may help spiny lobster, Nassau grouper and red hind coexist with the invasive lionfish by providing them with a distinct refuge and thus reduce competition and mortality.

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